CHAPTER 1

INTRODUCTION

1.1 Introduction

On-body communication is gaining popularity and has a large scope for research. It is a branch on body communications in which two or more devices on the body communicate using the surface of the body as the communication channel. It is often being applied in medical diagnostics and real time patient monitoring. Diversity has been used over the last few decades as a very powerful tool to combat fading in mobile wireless communication channels. Fading will occur due to the large relative movement of the body parts, shadowing, polarization mismatch, and scattering due to the body and the surrounding environment. To improve the performance and overcome fading, diversity is a very powerful tool. The principle behind diversity is the use of more than one independent and hence uncorrelated branch. If the various branch signals (channels) are uncorrelated significantly, the fading caused in the diversity branches is independent. A correlation coefficient of 0.7 or below is considered as an acceptable value to provide an improvement in terms of diversity for most of the cases [1]. A description of various diversity schemes is given in [2]. The use of multiple antennas at the transmitter and/or receiver is by far the most popular technique for diversity.

Much work has been done to investigate the body channel at the ISM bands such as 2.45 GHz. At this frequency, electromagnetic propagation involves two main aspects. Firstly, propagation takes place over the surface of the body by creeping or surface waves. Such propagation may be significantly affected by the motion of the body. Secondly, multipath propagation around the body, which is due to reflections from the surrounding environment and the body parts, will also occur. Propagation through the body is negligible at this and higher frequencies.

Diversity can be achieved in various ways such as frequency diversity, time diversity, and antenna diversity. Antenna diversity involves the use of multiple antennas, different radiation patterns, and/or polarizations [3]. Space diversity is by far the most popular technique, [3-5]. Space diversity is achieved by using more than one antenna at the transmitter or receiver side. This technique does not consume extra spectrum [3, 4] and the basic issue is that of antenna spacing. The diversity branches in the other antenna diversity techniques can be achieved by using different radiation patterns in the same or separate antennas and by using a single antenna with orthogonal polarizations or separate antennas with orthogonal polarizations [6]. When two antennas are placed close to each other, mutual coupling between the antennas must be low to prevent the effect of one antenna on the other. A spacing of $\lambda/2$ is sufficient for most of the applications [3].

The improvement due to the use of diversity is usually measured in terms of diversity gain (DG). DG is an improvement in the signal strength or signal to noise ratio or bit error rate over a single antenna with no diversity, at a certain level of outage probability [5,6]. DG depends upon the correlation and power imbalance between the two branch signals. If the power imbalance is more, the diversity combiner will favor the strongest signal for most of the time and hence a negligible diversity gain will result. For the on-body communication channels, pattern and polarization diversity antennas must be designed carefully to prevent one antenna being dominant compared to the other, for various positions and postures of the body, otherwise the high power imbalance can

severely affect the diversity performance. Due to limited changes in the antenna orientations for most of the on-body channels, the power imbalance will be larger if either the pattern or polarization of the diversity antennas is different.

In this project, the diversity performance for on-body communication channels will be review. Diversity gains and correlation coefficients will be report for various diversity scheme using different combining techniques in receiving monopole antennas and the best among the combining techniques will be identify using cumulative distribution functions (CDF) which will be plot for various movement of the body channels. In addition to the theoretical design procedure, numerical simulation was performed using CST microwave office suit at 5.8 GHz frequency to obtain design parameters such as S_{11}, S_{21}, feeding point location etc. The antennas have been fabricated and tested.

1.2 Objectives

The objectives of this project are:

(a) To study the concept of diversity schemes in terms of various type of diversity such as space, polarization, field, pattern diversity.

(b) To optimize, simulate, fabricate the space and polarization diversity antenna and investigate the data received from the simulation and measurement result by calculating its correlation coefficient and plots the

CDF using various types of combining techniques in order to know the best diversity performance.

1.3 Scopes of project

The scopes of this project will be defined as follows;

- Understanding the antenna concept
- Design the monopole antenna for transmitter, two patch antennas for the receiver (space) and polarized patch antenna for the receiver.
- Performs numerical solution using CST microwave office suit software.
- Practical implementation of the antenna.
- Comparison the measurement and simulation result in terms of correlation coefficient and various combining techniques.

1.4 Problem statement

As in traditional wireless communication systems, where distinctions among indoor and outdoor, urban and rural propagation environments have been identified, a body posture classification can be developed for on-body communications, since the relative position of the transmitting and receiving antennas significantly influences the system performance. Postures with different levels of mobility have been taken into account and generally roughly classified in sitting and standing. Free movements are allowed for each part of the body: leaning down, turning the trunk, walking, kneeling, and moving arms.

All these will contribute to the effect of fading for the channels on body communication, factors causing fading of an on body channel include multipath due to scattering from the sounding object and body parts, variation of distance between the antennas, polarization mismatches, shadowing.

The study of diversity antenna is to improve the performance by placing two antennas in the receiver so that the best signal will be selected no matter the position of the body

1.5 Project outlines

Chapter 1 provides the introduction of the project where the background, objectives and scopes of project are presented. Then, the literature review of the project which include

the fundamental theories and concept of diversity schemes in terms of (space, polarization, field, pattern etc) diversity, various types of antenna used on wireless communication and the appropriate literature are all described in Chapter 2. For Chapter 3, the methodology is explained. This part emphasized in equation and algorithm used in combining techniques on body communication Proceed with Chapter 4 Result and discussion followed by conclusion in Chapter 5. The conclusion will be summarized all the finding of the project.

1.6 Summary

This is an introductory chapter that defines the literature review, the objectives, and research background of the thesis. The project report structure is explained and highlighted. In the following chapters, the project work performed is reported.